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13. SUPPLEMENTARY NOTES					
14. ABSTRACT An acoustical assessment was performed on the Combat Arms Training and Maintenance (CATM) firing range facilities at Malmstrom AFB in May 2013. The noise characterization of the M240 CATM range Bldg 1892, as well as Bldg 1893 during the M4 and M870 class, meets the definition of impulse noise IAW AFOSH Standard 48-20. CATM instructors and students are still potentially exposed to peak sound pressure levels that exceed the allowable limits of AFOSH Standard 48-20. Therefore, it was recommended that hearing protection, either single or double, be worn during weapons live-fire training. The average noise decay times for the M4, M9, and M870 were each greater than 1 second, with peak SPLs greater than 115 dB; therefore, the noise is classified as continuous. According to AFOSH Standard 48-20, Table 3, there is no allowed exposure time above 115 dBA.					
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DEPARTMENT OF THE AIR FORCE
USAF SCHOOL OF AEROSPACE MEDICINE (AFMC)
WRIGHT-PATTERSON AFB OH

22 November 2013

MEMORANDUM FOR 341 MDOS/SGOJ
ATTN: MAJ BRIAN CLARKE
7300 NORTH PERIMETER ROAD
MALMSTROM AFB, MT 59402

FROM: USAFSAM/OEC
2510 Fifth Street
Wright-Patterson AFB, OH 45433

SUBJECT: Consultative Letter, AFRL-SA-WP-CL-2013-0024, Acoustical Evaluation of
Combat Arms Firing Range, Malmstrom AFB, Montana

1. INTRODUCTION:

a. *Purpose:* On 13-22 May 2013, the United States Air Force School of Aerospace Medicine, Consultative Services Division (USAFSAM/OEC), at the request of AFGSC/SGPB and 341 MDOS/SGOJ, conducted an acoustical evaluation of the Combat Arms Training and Maintenance (CATM) firing range facilities at Malmstrom AFB, Montana. The process of assessing impulse noise at a CATM firing range is a very complex task using specialized equipment to assess hazardous noise environments. USAFSAM/OEC is the only AF resource with both the skilled personnel and equipment to accomplish these risk management/mitigation surveys. The purpose of this assessment was to classify the measured noise exposure as continuous or impulse; explain how the classification pertains to AFOSH Standard 48-20, *Occupational Noise and Hearing Conservation Program*; and provide recommendations for mitigating exposure to hazardous noise.

b. *Survey Personnel:* Two Bioenvironmental Engineering Technicians, USAFSAM/OEC.

c. *Personnel Contacted:*

- (1) Bioenvironmental Engineer, 341 MDOS/SGOJ
- (2) Bioenvironmental Engineering Technician, 341 MDOS/SGOJ
- (3) NCOIC, Combat Arms, 341 SSPTS/S4C
- (4) Combat Arms Instructor, 341 SSPTS/S4C

d. *Equipment:*

- (1) B&K PULSE Analyzer, Type 3560-B-140, SN 2588445
- (2) Larson Davis Microphone Pre-amplifier power supply, Type 2221, SN 0203,0200
- (3) Larson Davis Microphone, Model # 2530, SN 1492, 1489
- (4) Larson Davis Microphone Pre-amplifier, Model PRM902, SN 3826
- (5) Quest Calibrator, Model # QC-20, SN QF8050050

2. BACKGROUND:

a. There are two operational CATM firing ranges at Malmstrom AFB. The first range, Bldg 1893, is partially enclosed with 26 total firing lanes (see Figures 1 and 2) and is used to train personnel on M4, M9, and M870 weapons firing. A noise-reverberant field occurs during firing where the noise energy is reflected off the ceiling, walls, and floor surfaces, thereby increasing noise levels for a longer duration. Down-range targets are located outdoors at the 7-, 15-, and 25- meter lines with a coarse sand earth berm to stop bullets.



Figure 1. Bldg 1893, CATM Range Lanes 1-26 for M4, M9, and M870



Figure 2. Bldg 1893, CATM Range for M4, M9, and M870

The second range, Bldg 1892, is partially enclosed with five total firing lanes (see Figures 3 and 4) and is used to train personnel on M240 weapons firing. Just past the firing line are five cement tubes through which the weapons are fired. The targets are placed approximately 5 feet after the cement tubes with a coarse sand earth berm to stop bullets.



Figure 3. Bldg 1892, CATM Range Lanes 1-5 for M240



Figure 4. Bldg 1892, CATM Range for M240

b. Engineering controls were added to the M240 range in 2012. These controls include sound-absorption materials added to the ceiling, side walls, and back wall of Bldg 1892, as shown in Figure 5. Bldg 1893 CATM range does not have any sound-absorption material installed in the building.

c. According to AFOSH Standard 48-20, the maximum level of **continuous noise** that is allowed to reach the ear shall not exceed 115 dBA and the maximum level of **impulse noise** that is allowed to reach the ear shall not exceed 140 dB peak sound pressure level (SPL).

3. METHODOLOGY:

a. Process Description: The CATM firing ranges are used to train and qualify base personnel on multiple weapons systems. The firing ranges have two distinct painted floor lines that are used for reference. The first point of reference is the yellow safety line. Students must stand behind this line while not actively firing a weapon. The second point of reference is the red firing line, which is located 5 feet forward of the yellow safety line. The red line is where each student actively fires a weapon at a down-range target. During live-fire weapons training classes, instructors are positioned along the yellow line to ensure the range is safe and to assist students when needed. During all live fire training classes in Bldg 1893, only the doors at each occupied firing lane are opened. During this assessment, CATM instructors were observed wearing dual hearing protection (Peltor earmuffs and Radians Resistor earplugs) at both firing ranges.

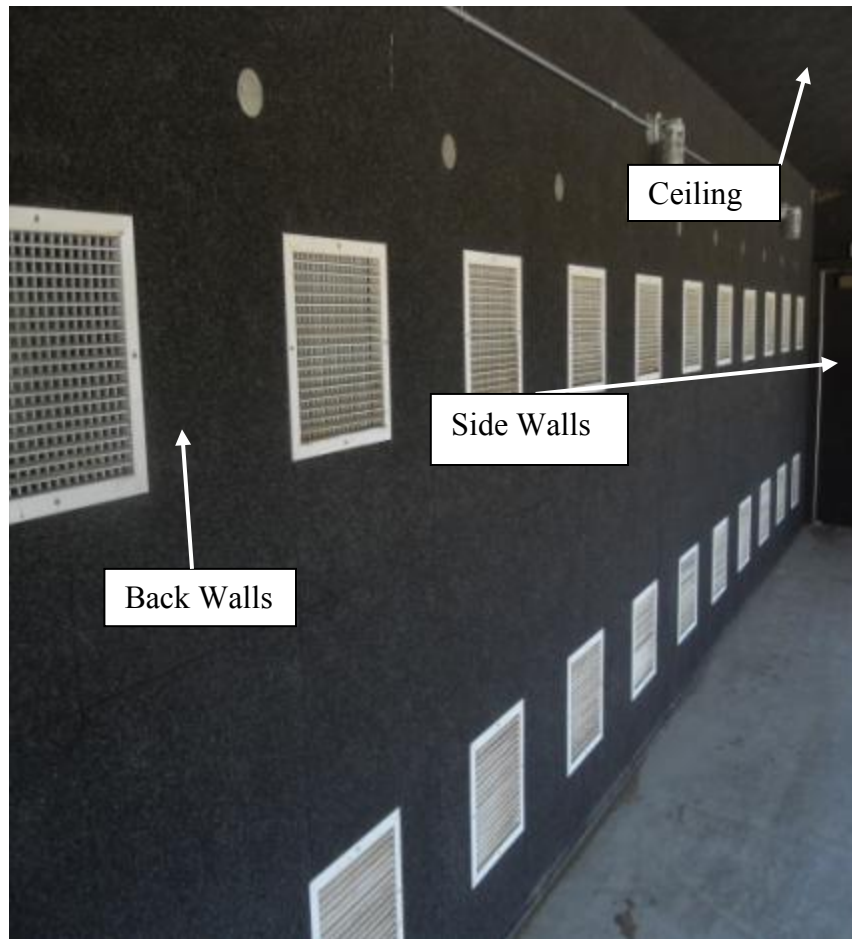


Figure 5. Bldg 1892, Sound-Absorbing Material

b. *Sample Procedure:* The SPL time histories corresponding to individual M4, M9, and M870 weapons firings were measured with a $\frac{1}{4}$ -inch microphone placed 5 feet above ground level along the yellow safety line; see Figure 6 for microphone position in Bldg 1893. SPL time history data for the M240 machine gun were collected while three base members separately fired 1000 rounds each on firing lanes 1, 3, and 5. During this class, the CATM instructor provided one-on-one oversight to the shooter and was positioned directly to the right of the student, approximately 4 feet away. Therefore, the microphone was positioned as close to the instructor as possible and approximately 4 feet above the ground; see Figure 7 for M240 microphone position in Bldg 1892. Time histories are measured SPLs over a duration of approximately 4 seconds. This duration provided sufficient time to characterize the decay of the acoustical energy to background levels. These time histories were then used to compute acoustical decay characteristics.

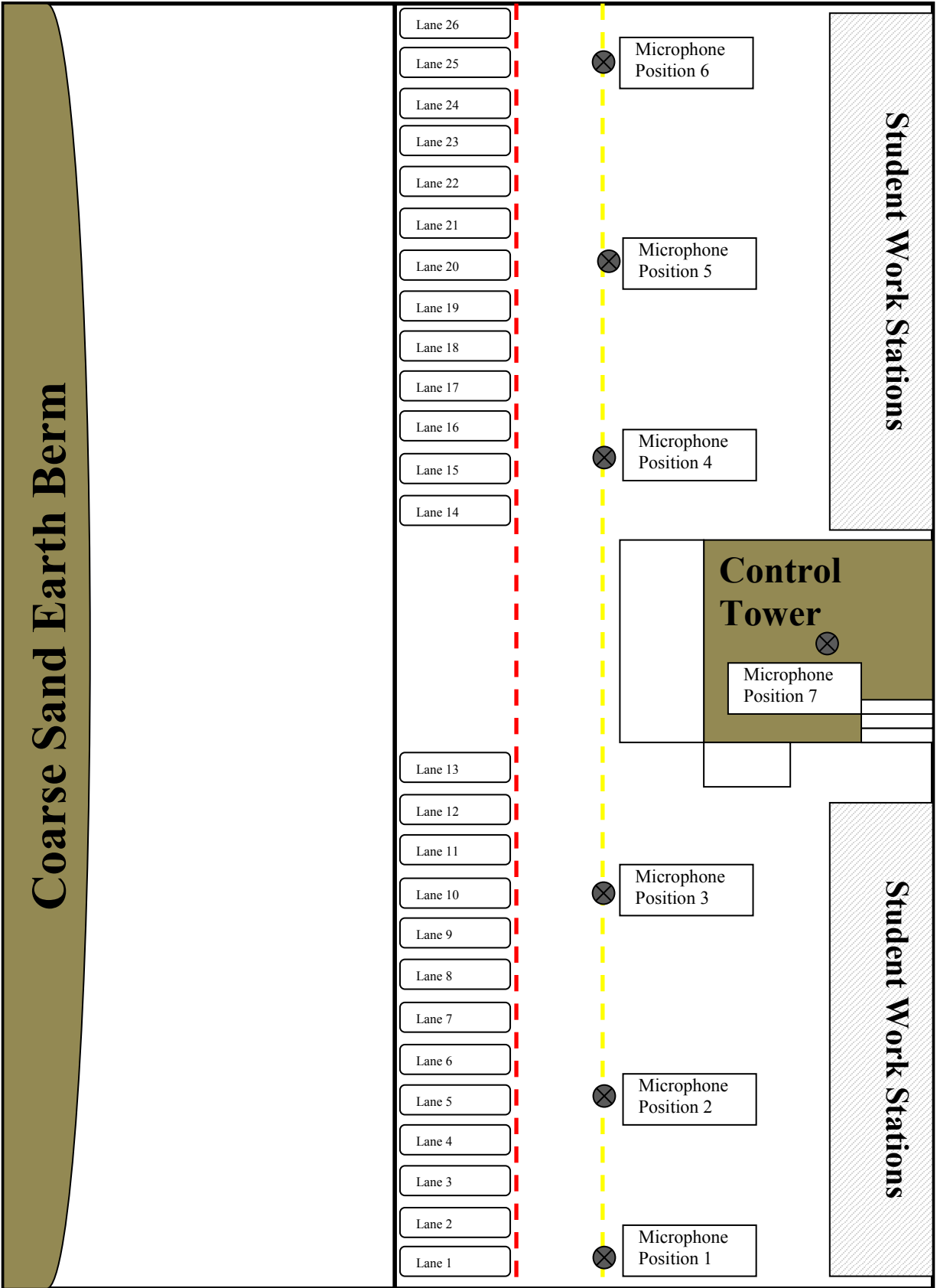


Figure 6. Malmstrom AFB CATM Range Bldg 1893 Layout and Microphone Position

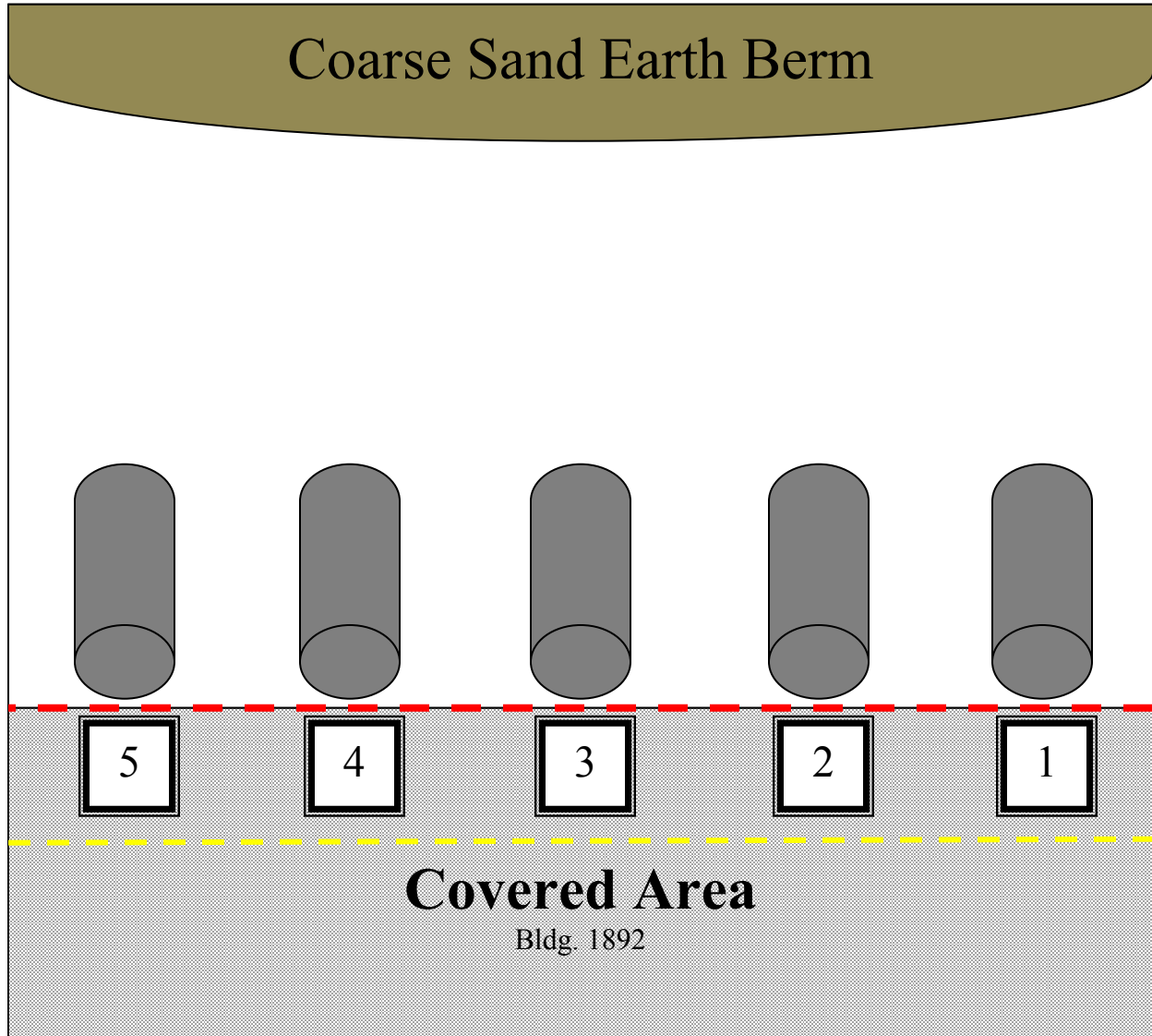


Figure 7. Malmstrom AFB CATM 240 Range Bldg 1892 Layout and Microphone Position

c. The linear SPL decay rates, in decibels per second, were computed by selecting the linear decay phase of each time history and performing a sound level versus time analysis through the decay phase. Decay times are calculated from the linear slope from 150 dB down to 80 dB. The slope of this curve is the decay rate.

d. SPL time history data were collected in six phases to represent the spectrum of exposure scenarios typical at these ranges. During all phases of data collection, a minimum of five SPL time histories were collected at each identified microphone position.

(1) During the first phase, 22 base personnel each shot an M4 on firing lanes 1-12 and 15-24.

(2) For the second phase, M4 data were collected while one Security Forces airman shot an M4 at firing lane 11.

(3) Due to CATM not having an M9 class scheduled during this assessment, the third phase of data collection was accomplished while one CATM instructor shot the M9 from firing lane 11.

(4) During the fourth phase, M240 data were collected while three base personnel each shot an M240 at firing lanes 1, 3, and 5.

(5) The fifth phase of data collection was accomplished while one CATM instructor shot the M870 from firing lane 11.

(6) For the sixth phase, M870 data were collected while 24 base personnel each shot an M870 at firing lanes 1-12 and 14-25.

4. RESULTS:

a. Under the monitored conditions, the noise characterization of the M240 CATM range Bldg 1892, as well as Bldg 1893 during the M4 and M870 class, meets the definition of **impulse noise** IAW AFOSH Standard 48-20. The definition states that impulse noise is “a short burst of acoustic energy consisting of either a single burst or a series of bursts. The pressure-time history of a single burst includes a rapid rise to a peak pressure followed by a somewhat lower decay of the pressure envelope to ambient pressure, both occurring **within 1.0 second**. A series of impulses may last longer than 1.0 second.”

b. Under the monitored conditions of the single-shooter portion of this assessment, the average noise decay times for the M4, M9, and M870 were each greater than 1 second, with peak SPLs greater than 115 dB; therefore, the noise is classified as continuous. According to AFOSH Standard 48-20, Table 3, there is no allowed exposure time above 115 dBA.

c. The average decay time and noise characterization of the four different types of weapons are summarized in Table 1.

Table 1: Noise Characterization by Decay Time

Weapons System/Class Type	Average Decay Time (s)	Noise Characterization	Peak SPL (dB)	Maximum <i>Unprotected Impulse</i> Noise Level (dB)	Maximum <i>Unprotected Continuous</i> Noise Level (dB)	Exceeds Impulse Noise Std (Yes/No)	Exceeds Continuous Noise Std. (Yes/No)
M4class	0.7	Impulse	148	140	N/A	Yes	N/A
M4 single shooter	1.3	Continuous	139	N/A	115	N/A	Yes
M9 single shooter	1.2	Continuous	140	N/A	115	N/A	Yes
M240 class	0.4	Impulse	150	140	N/A	Yes	N/A
M870 class	0.7	Impulse	157	140	N/A	Yes	N/A
M870 single shooter	1.2	Continuous	142	N/A	115	N/A	Yes

5. CONCLUSION:

a. The in-place engineering controls installed at the M240 CATM range have effectively changed the noise classification from continuous to impulse noise; however, peak SPLs remain above the allowable unprotected level of 140 dB.

b. The in-place engineering controls (firing lane doors opened) during the M4 and M870 class in Bldg 1893 allow the noise in the range to be classified as impulse; however, peak SPLs remain above the allowable unprotected level of 140 dB.

c. During M4, M9, and M870 single-shooter weapons training, all firing lane doors except the lane being occupied are closed. The noise is classified as continuous during these events. Based on the continuous noise standard, there is no allowed exposure time above 115 dBA.

6. RECOMMENDATIONS:

a. **Install sound-absorbing material in Bldg 1893 to reduce the reverberant field.** The reverberant field in the range should be minimized to reduce the noise level to protect instructors and students from hazardous noise exposure and to improve speech intelligibility. Treat the firing area's ceiling, side walls from the red line back, and the rear wall with acoustical absorption material in accordance with Engineering Technical Letter, 11-18: Small Arms Range Design and Construction, para 7.2.9 through 7.2.9.4. Quilted fiberglass, or other fiberglass panels wrapped in a manor allowing easy cleaning, is one option. There are also more fixed installation materials available, such as products offered by Pyrok or Troy Acoustics. The goal of the sound-absorbing material is to reduce noise decay time to less than 1 second and reduce peak SPLs below 140 dB IAW AFOSH Standard 48-20, para 2.11.3.1.

b. Continue to wear dual hearing protection (Peltor earmuffs and Radians Resistor earplugs) during all live firing at the range.


c. Until effective engineering controls can be implemented in Bldg 1893, all firing lane doors need to be opened for the duration of weapons firing training during all live fire training classes regardless of the number of students qualifying.

d. Until effective engineering controls can be implemented in Bldg 1893, consider close scrutiny to audiograms as defined in AFOSH Standard 48-20, para 2.12.3, for all CATM instructors, as they **are not** adequately protected in the current range configuration with personal protective equipment and administrative controls.

e. CATM instructors should provide just-in-time training to students on proper use of hearing protection devices as part of classroom instruction. NIOSH has a short video on proper insertion of foam ear plugs available for download at <http://www.cdc.gov/niosh/mining/products/movies/rphhi.wmv>.

f. Request a USAFSAM follow-up noise assessment after acoustical treatment of the range is complete.

7. If you have any further questions regarding this report, please contact TSgt Gene Moll at DSN 798-3294 or gene.moll@us.af.mil. Please direct any questions or comments regarding Industrial Hygiene Consultative support to Maj Alan Hale at DSN 798-3320 or alan.hale@us.af.mil. To improve our services, please complete the critique located at <https://www.surveymonkey.com/s/OECUSTOMERSURVEY>.



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